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GB 2086062 A GB 2082785 A

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(54) Electrical power supply meters

(57) Electronic electrical power supply meters are limited by statutory regulation in the current which they are permitted to draw from a mains supply to which they are connected. It is often desirable to include opto-transmitters in an electronic meter in order to facilitate automatic or remote meter reading. Opto-transmitters can demand significant current which may cause the current limit to be exceeded. By arranging that the opto-transmitter 13 is connected in series with the DC power supply rails of the meter between rectifier 11 and voltage regulator 12, power for opto-transmitter, is arranged to be provided using current which is used also to operate the meter measurement circuits 8. In order to achieve this adaptation, it is necessary to ensure that the circuit which includes the opto-transmitter does not cause ripple in the DC power supply rail when the opto-transmitter is modulated.

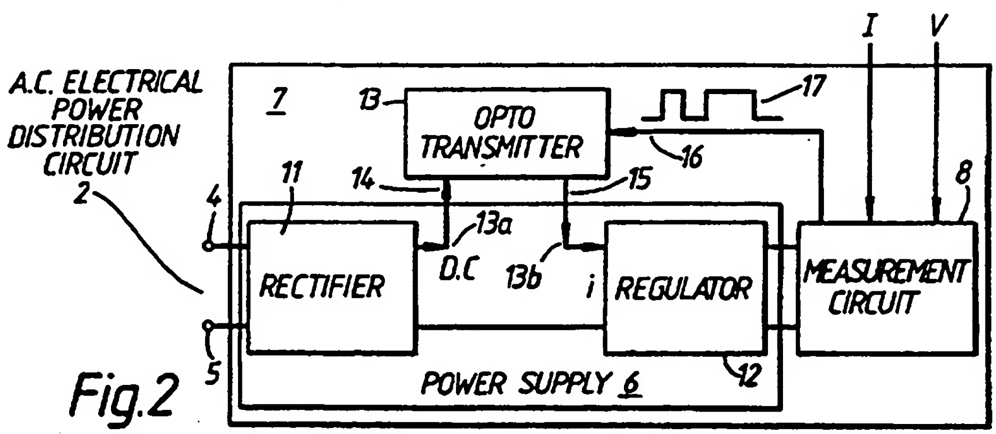

Fig.2

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At least ne drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

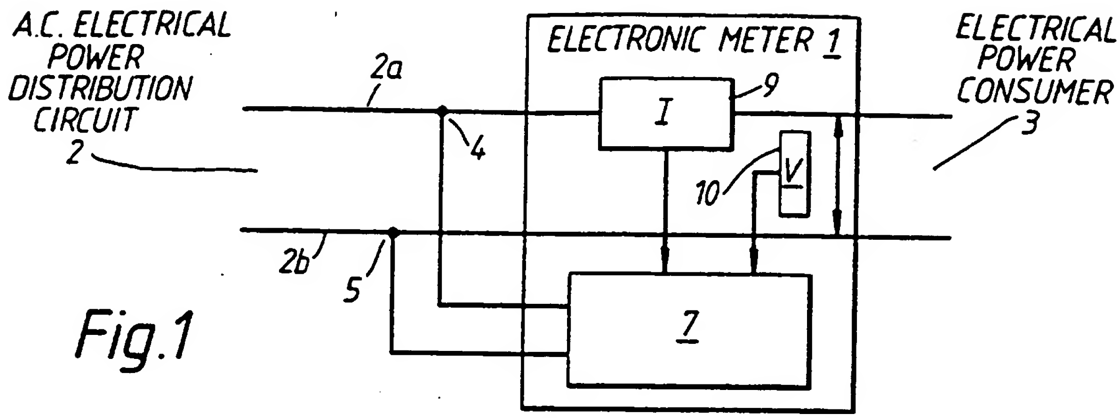

Fig.1

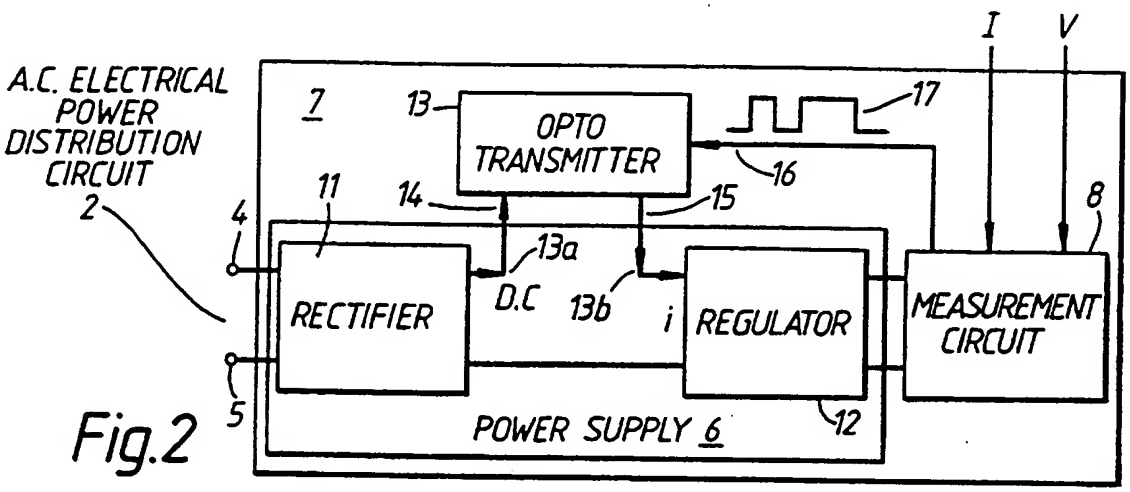

Fig.2

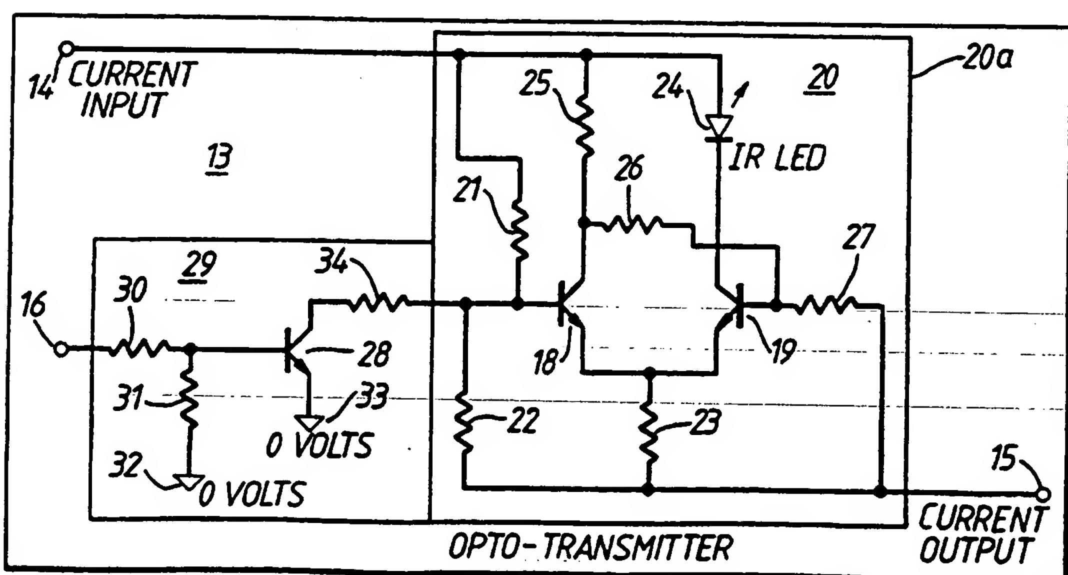

Fig.3

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IMPROVEMENTS IN OR RELATING TO ELECTRICAL POWER SUPPLY METERS

The present invention relates to electronic meters for measuring electrical power fed from an electrical power distribution circuit to an electrical power consumer, and in particular it relates to such meters which embody optical transmitter (opto-transmitter) circuits.

The term opto-transmitter when used herein includes devices which operate using light in the visible or non-visible spectra.

An electronic meter for measuring electrical power fed from an electrical power distribution circuit to an electrical power consumer, itself requires electrical power in order to function. A convenient way of providing this power, is to furnish the electronic meter with means for drawing electrical power from the electrical power distribution circuit used to supply the consumer. However, the current which an electronic meter is permitted to draw from an electrical power distribution circuit is limited by statutory regulation.

An electronic meter which draws power from an electrical power distribution circuit, typically includes a rectifier and a regulator as part of a power supply unit. The rectifier is used to convert alternating current (AC) from the electrical power distribution circuit to direct current (DC) as required by the regulator. The regulator operates to provide current at a stabilised voltage for a measurement circuit which affords the

measurement functions of the meter. An electronic meter therefore may comprise parts including a regulator, a rectifier, and a measurement circuit and any other parts as may be required for its operation or to extend its functionality, such as means for enabling it to be read automatically by some other unit attached to it or remote from it.

A typical way in which an electronic meter is provided with a facility for remote metering is by use of an opto-transmitter circuit which may be arranged to communicate a meter reading represented by a signal comprising modulated light pulses, to an optical receiver for demodulating the signal. The meter reading may be further transmitted by other means such as electrical or radio signals. An opto-transmitter circuit therefore may provide a facility for an electronic meter to be read by a second metering device which is both physically separate and electrically isolated from the electronic meter being read.

In known arrangements of electronic meters embodying opto-transmitter circuits, the opto-transmitter circuit is connected with a measurement circuit to a power supply. The opto-transmitter circuit therefore draws current from a regulator of the power supply unit, in addition to that drawn by the measurement circuit.

Opto-transmitter circuits can demand significant current which may cause the statutory limit on current which may be drawn from an electrical power distribution circuit for metering purposes, to be exceeded. This is because the current used for

operation of the measurement circuit, and the opto-transmitter circuit must both be included in this limit.

It is an object of the present invention to provide an electronic meter which facilitates incorporation of an opto-transmitter circuit, without the statutory current limit being exceeded.

It is a further object of the present invention to provide an electronic meter embodying an opto-transmitter circuit, which can be modulated without introducing significant voltage ripple.

According to the present invention an electronic meter for measuring electrical power fed from an electrical power distribution circuit to an electrical power consumer, comprises a power supply for providing DC electrical power to the electronic meter, a measurement circuit affording the measurement capability of the electronic meter, and an opto-transmitter circuit for communicating data appertaining to a meter reading, wherein the power supply includes a rectifier connected to the electrical power distribution circuit for converting AC current from the said power distribution circuit into DC current, and a regulator which uses the DC current to provide a stabilised voltage for operation of the measurement circuit, and wherein the opto-transmitter circuit is connected in series between the rectifier and the regulator so that the DC current fed from the rectifier to the regulator and the measurement circuit flows through the opto-transmitter circuit.

As will be appreciated by those skilled in the art, by connecting the opto-transmitter circuit in series with the rectifier and the regulator, said opto-transmitter circuit is arranged to be

powered in a way which does not significantly increase the current demanded by the electronic meter above that demanded by the regulator and the measurement circuit.

The opto-transmitter circuit for series connection between the rectifier and the regulator, may comprise a switching means which switches, when triggered, to divert the DC current from one to the other of two conducting paths, a light emitting device which emits light when current flows through it connected in the said one conducting path, and a load resistor having a resistance substantially equal to that of the said light emitting device connected in the said other conducting path, the load resistor and said light emitting device being connected to the switching means so that the DC current flowing through the said opto-transmitter circuit flows either through the load resistor or through the said light emitting device, the current being the same whether flowing through the load resistor or the said light emitting device, thereby obviating the generation of any ripple voltage which might otherwise result when the said device is modulated consequent upon operation of the switching means.

By providing a load resistor connected on one conducting path of the switching means which has a resistance which is substantially equal to the light emitting device connected on the other conducting path of the switching means, the same current will flow through the opto-transmitter circuit when either path is conducting, enabling the light emitting device to be modulated in accordance with data to be transmitted, without causing significant ripple voltage.

The switching means may be a Schmitt trigger means.

The Schmitt trigger means may comprise a Schmitt trigger and a voltage level shifter.

The Schmitt trigger embodied in the opto-transmitter circuit, may comprise a first transistor, a second transistor, the emitter of which second transistor being connected to the emitter of the first transistor and through a first resistor to a lower potential side of the said opto-transmitter circuit, the base of which second transistor being connected through a second resistor to the said lower potential side of the said opto-transmitter circuit, third and fourth resistors being connected at the base of the first transistor so as to form a potential divider between a higher potential side and the lower potential side of the said opto-transmitter circuit which potential divider being arranged to provide a voltage bias at the base of the first transistor so that the first transistor is biased 'on', and a fifth resistor being connected between the collector of the first transistor and the base of the second transistor, the resistance of which fifth resistor being chosen so that the second transistor is 'off' when the first transistor is 'on', and the collector of the second transistor being connected through the light emitting device to the higher potential side of the said opto-transmitter circuit, which light emitting device completes the said one conducting path through the second transistor, and the collector of the first transistor being connected through the load resistor to the said higher potential side of the said opto-transmitter circuit, which load resistor completes the said other conducting path through the first transistor, and the

voltage level shifter being connected to the base of the first transistor for shifting the level of the voltage bias in accordance with serial binary data to be transmitted by the said opto-transmitter circuit, and the shift in the level of the said voltage bias being sufficient to cause the first transistor to turn 'off' and the second transistor to turn 'on', thereby triggering the Schmitt trigger and causing light to be emitted by the said light emitting device as it is energised, when the first transistor is 'off' and the second transistor 'on'.

The voltage level shifter of the opto-transmitter circuit may comprise a third transistor the collector of which is connected through a sixth resistor to the base of the first transistor of the Schmitt trigger embodied in the said opto-transmitter circuit, the emitter of the third transistor being connected to ground, and seventh and eighth resistors connected at the base of the third transistor so as to form a potential divider between an input terminal and ground for application of serial binary data, thereby causing a voltage level shift at the base of the first transistor sufficient to change its conducting state, in accordance with the serial binary data applied to the said input terminal.

The light emitting device may be a light emitting diode.

The light emitting device may be a diode emitting light in the infra red spectrum.

One embodiment of the invention will now be described by way of example only, with reference to the accompanying drawings, in which.

FIGURE 1 is a somewhat schematic block circuit diagram of an electronic meter, for metering electricity fed to a consumer from a power distribution circuit.

FIGURE 2 is a somewhat schematic block circuit diagram of parts of an electronic meter including an opto-transmitter circuit wherein those parts of the electronic meter shown in Figure 1 bear the same numerical designations.

FIGURE 3 is a circuit diagram of an opto-transmitter circuit, wherein those parts shown also in Figure 2 bear the same numerical designations.

In Figure 1 an electronic meter 1 is shown connected to an AC electrical power distribution circuit 2, for metering electrical power fed therefrom to a consumer 3. Although the AC electrical power distribution circuit 2, is shown herein having two conductors 2a and 2b, the power distribution circuit 2 could alternatively comprise of more than two conductors, one or more of which may be live. The electronic meter 1, draws power for its operation from the electrical power distribution circuit 2. The electronic meter 1 is connected to the power distribution circuit 2 at points 4, 5, via the two conductors 2a, 2b, which conductors enter the meter 1 and are connected to a power supply 6 as shown in Figure 2 within a unit 7.

Within the unit 7, a measurement circuit 8 measures power fed to the consumer 3, in accordance with current as sensed by a current measurement circuit 9, and voltage as sensed by a voltage measurement circuit 10, which respectively measure a current *I* drawn by the consumer 3, and a voltage *V* at which the current *I*

is supplied. The measurement circuit 8, forms a signal representative of the product $V \times I$. This signal is integrated over time to produce a measure of the electrical energy supplied to the consumer 3. The total electrical energy supplied to the consumer 3, is then displayed for inspection by the consumer, using a digital display (not shown).

Parts which comprise the unit 7 of the electronic meter 1, are shown in Figure 2. The two conductors 2a, 2b, which are connected to the AC electrical power distribution circuit 2, at the points 4, 5, enter the unit 7 and form electrical connections with a rectifier 11, which rectifier forms part of the power supply 6. The rectifier 11, converts AC into DC as required by a regulator 12, also forming part of the power supply 6. The regulator 12, supplies current to the measurement circuit 8, at a stabilised voltage. An opto-transmitter circuit 13, is connected in series between the rectifier 11 and the regulator 12, so that the DC current drawn by the regulator 12 from the rectifier 11, flows via the opto-transmitter circuit 13.

Statutory regulation limits the current which the electronic meter 1 may draw from the power distribution circuit 2. The total current drawn by the regulator 12 and the measurement circuit 8 is shown in Figure 2 as i. This current i flows in conductors 13a, 13b, between the rectifier 11, the opto-transmitter circuit 13 and the regulator 12. If the opto-transmitter circuit 13 were to be connected to the output of the regulator 12, together with the measurement circuit 8, the total current provided by the rectifier 11 drawn from the power

distribution circuit 2, might well exceed the statutory limit. However by connecting the opto-transmitter circuit 13 in series between the rectifier 11 and the regulator 12, power consumed by the opto-transmitter circuit 13, is provided by the DC current *i* drawn by the regulator 12 and the measurement circuit 8, alone. This current *i* , enters the opto-transmitter circuit 13, at a terminal 14, and leaves at a terminal 15. The voltage provided at the input to the regulator 12, therefore corresponds to a voltage provided at the output of the rectifier 11, less a voltage dropped across the opto-transmitter circuit 13. However, because the voltage dropped across the opto-transmitter circuit 13, is relatively small, operation of the regulator 12, and the measurement circuit 8 is not impaired.

In operation, serial binary data appertaining to a meter reading is applied to the terminal 16 of the opto-transmitter circuit 13, for modulating a light emitting device 24 (as shown in Figure 3) forming part of the circuit 13. In Figure 2, this data is represented by a wave form 17, which wave form 17 is provided by the measurement circuit 8. The regulator 12 must provide an accurate stabilised reference voltage for the measurement circuit 8, and therefore, any electrical disturbance or ripple on the DC supply is clearly undesirable. Modulation of the light emitting device 24 might normally be expected to cause ripple voltage on the conductor 13b, which completes the circuit between the opto-transmitter circuit 13 and the regulator 12. However an arrangement for an opto-transmitter which provides for

modulation of the light emitting device 24 without causing such ripple voltage is shown in Figure 3.

The opto-transmitter circuit 13 shown in Figure 3 has three connection terminals designated 14, 15 and 16. As hereinbefore explained the terminal 14 is connected to the rectifier 11 whereas the terminal 15 is connected to the regulator 12. The current *i*, shown in figure 2, therefore flows through the circuit of Figure 3, resulting in the terminal 14 being at a higher potential difference than the terminal 15.

In the opto-transmitter circuit 13, of Figure 3, two transistors 18 and 19 and their associated resistors form a Schmitt trigger 20, as shown in box 20a. Connected to the base of the transistor 18 are two resistors 21 and 22, which form a potential divider between the terminals 14 and 15. The resistor 21, is connected between the base of the transistor 18 and the terminal 14, and the resistor 22, is connected between the base of the transistor 18 and the terminal 15. The potential divider provides a bias voltage at the base of the transistor 18 which ensures that in a stable state of the Schmitt trigger, the transistor 18 is 'on'. The emitter of the transistor 18 is connected to the emitter of the transistor 19 and both emitters are connected through a resistor 23, to the terminal 15. A first conducting path of the Schmitt trigger 20, is completed, between the terminals 14 and 15, by an infra red light emitting diode (IR LED) 24, which is connected between the collector of the transistor 19, and the terminal 14. A second conducting path is completed by a load resistor 25, which is connected between the collector of the transistor 18 and the

terminal 14. The load resistor 25, is arranged to have a resistance which is approximately equal to that of the IR LED 24.

In the stable state of the Schmitt trigger 20, the transistor 18 is arranged to be biased 'on' by the resistors 21 and 22 as aforementioned. In this state the transistor 19 is arranged to be held 'off' by a resistor 26, which is connected between the base of the transistor 19 and the collector of the transistor 18. A circuit defining the Schmitt trigger 20, is completed by a resistor 27, connected between the base of the transistor 19 and the terminal 15. In the stable state, current flows between the terminals 14 and 15 via the load resistor 25 and the transistor 18, and no current flows through the IR LED 24, and the transistor 19.

A transistor 28, and its associated resistors form a voltage level shifter 29, which is used to trigger the Schmitt trigger 20. A terminal 16, is connected through two resistors 30 and 31, to ground marked '0' volts at point 32. The resistors 30 and 31 form a potential divider at a point between them where the base of the transistor 28 is connected. The emitter of the transistor 28 is connected to ground marked '0' volts at a point 33. The collector of the transistor 28 is connected via a resistor 34, to the base of the transistor 18.

With the voltage at the terminal 16, at 0 volts, corresponding to a logic '0', the transistor 28 is 'off', ensuring that the transistor 18 is 'on', and the Schmitt trigger remains in the stable state. When the voltage at the terminal 16, goes high, corresponding to a logic '1', the transistor 28 conducts causing the voltage at the base of the transistor 18 to fall to a level sufficient

to turn the transistor 18 'off', triggering the Schmitt trigger. This causes the voltage at the collector of the transistor 18 to rise, causing the transistor 19 to turn 'on' and the current *i* to flow through the transistor 19 and the IR LED 24, instead of the transistor 18 and the load resistor 25. Light is emitted by the IR LED 24, for as long as the voltage at the terminal 16 is high. Furthermore the current *i* flowing through the IR LED 24, is equal to the current which flowed through the load resistor 25, when the transistor 18 was 'on' and the transistor 19 was 'off'.

The same DC current *i* will flow from the terminal 14 to the terminal 15, whether it is flowing through the first conducting path of the Schmitt trigger 20, containing the load resistor 25, or the second conducting path containing the IR LED 24. Ripple voltage between the terminals 14 and 15, on modulation of the IR LED does not therefore occur or at least is minimised.

By adopting the principles of this circuit, an LED or any other light emitting device may be energised without causing significant ripple voltage on the conductor connecting the rectifier 11 to the regulator 12.

As an alternative, a simpler and less expensive opto-transmitter circuit could perhaps be used at the expense of introducing ripple voltage on the DC supply conductors 14, 15, but, this would result in a requirement for a more sophisticated and therefore more expensive regulator circuit, which would of necessity need to include means for removing this ripple voltage.

WHAT WE CLAIM IS:

1. An electronic meter for measuring electrical power fed from an electrical power distribution circuit to an electrical power consumer, comprising a power supply for providing DC electrical power to the electronic meter, a measurement circuit affording the measurement capability of the electronic meter, and an opto-transmitter circuit for communicating data appertaining to a meter reading, wherein the power supply includes a rectifier connected to the electrical power distribution circuit for converting AC current from the said power distribution circuit into DC current, and a regulator which uses the DC current to provide a stabilised voltage for operation of the measurement circuit, and wherein the opto-transmitter circuit is connected in series between the rectifier and the regulator so that the DC current fed from the rectifier to the regulator and the measurement circuit flows through the opto-transmitter circuit.

2. An electronic meter as claimed in claim 1, wherein the opto-transmitter circuit, comprises a switching means which switches, when triggered, to divert the DC current from one to the other of two conducting paths, a light emitting device which emits light when current flows through it connected in the said one conducting path, and a load resistor having a resistance substantially equal to that of the said light emitting device connected in the said other conducting path, the load resistor and said light emitting device being connected to the switching means so that the DC current flowing through the said opto-transmitter

circuit flows either through the load resistor or through the said light emitting device, the current being substantially the same whether flowing through the load resistor or the said light emitting device, thereby obviating the generation of any ripple voltage which might otherwise result when the said light emitting device is modulated consequent upon operation of the switching means.

3. An electronic meter as claimed in Claim 2, wherein the switching means is a Schmitt trigger means.

4. An electronic meter as claimed in Claim 3, wherein the Schmitt trigger means comprises a Schmitt trigger and a voltage level shifter.

5. An electronic meter as claimed in Claim 4, wherein the Schmitt trigger, comprises a first transistor, a second transistor, the emitter of which second transistor being connected to the emitter of the first transistor and through a first resistor to a lower potential side of the said opto-transmitter circuit, the base of which second transistor being connected through a second resistor to the said lower potential side of the said opto-transmitter circuit, third and fourth resistors being connected at the base of the first transistor so as to form a potential divider between a higher potential side and the lower potential side of the said opto-transmitter circuit which potential divider being arranged to provide a voltage bias at the base of the first

transistor so that the first transistor is biased 'on', and a fifth resistor being connected between the collector of the first transistor and the base of the second transistor, the resistance of which fifth resistor being chosen so that the second transistor is 'off' when the first transistor is 'on', and the collector of the second transistor being connected through the light emitting device to the higher potential side of the said opto-transmitter circuit, which light emitting device completes the said one conducting path through the second transistor, and the collector of the first transistor being connected through the load resistor to the said higher potential side of the said opto-transmitter circuit, which load resistor completes the said other conducting path through the first transistor, and the voltage level shifter being connected to the base of the first transistor for shifting the level of the voltage bias in accordance with serial binary data to be transmitted by the said opto-transmitter circuit, and the shift in the level of the said voltage bias being sufficient to cause the first transistor to turn 'off' and the second transistor to turn 'on', thereby triggering the Schmitt trigger and causing light to be emitted by the said light emitting device as it is energised, when the first transistor is 'off' and the second transistor 'on'.

6. An electronic meter as claimed in Claim 4 or 5, wherein the voltage level shifter of the opto-transmitter circuit, comprises a third transistor, the collector of which third transistor is connected through a sixth resistor to the base of the first transistor of the Schmitt trigger, the emitter of the third transistor being connected

to ground, and seventh and eighth resistors connected at the base of the third transistor so as to form a potential divider between an input terminal and ground for application of serial binary data, thereby causing a voltage level shift at the base of the first transistor sufficient to change its conducting state, in accordance with the serial binary data applied to the said input terminal.

7. An electronic meter as claimed in any preceding claim, wherein the light emitting device is a light emitting diode.

8. An electronic meter as claimed in Claim 7, wherein the light emitting device is a diode capable of emitting light in the infra red spectrum.

9. An electronic meter substantially as hereinbefore described with reference to the accompanying drawings.

The Patent Office

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Application No:	GB 9511525.9	**Examiner:**	John Betts
Claims searched:	1-9	**Date of search:**	24 August 1995

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Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

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H4B (BK4, BK14C2, BK14D2, BK14D2B, BK14D2C, BK14D2D)

Int Cl (Ed.6): G01R 21/00, 21/06, 21/127, 21/133; G08C 23/04, 23/06

Other: On-Line: WPI, CLAIMS, INSPEC.

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	GB2086062 A (Rochester) See Fig.2	
A	GB2082785 A (Valeron) see Fig. 1	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
		E	Patent document published on or after, but with priority date earlier than, the filing date of this application.
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